BACTrack: A Surveillance Technique for Detecting and Locating Bioagent Attacks

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An Example Scenario

Attack Phase – day 0

Attack Location

- **Covert Anthrax attack on T station**
- **Victims are infected but show no signs of illness**

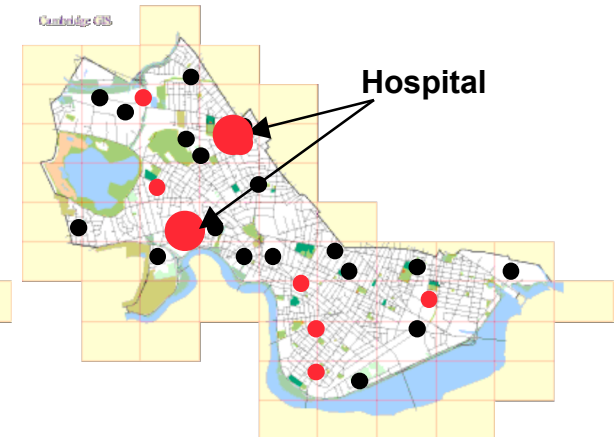> **Localized population**
> **Timely**
> **Not detectable**

Early Symptom Phase – day 2
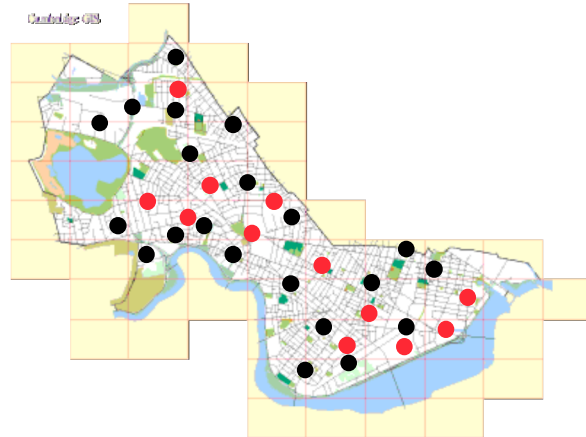
- **Some victims show non-specific symptoms**
- **Victims are widely distributed geographically**

> **Cannot detect**
> **Cannot localize**

Treatment Phase- day 5

Hospital

- **More victims begin to show signs of illness**
- **The sickest victims report to ER and doctors offices**
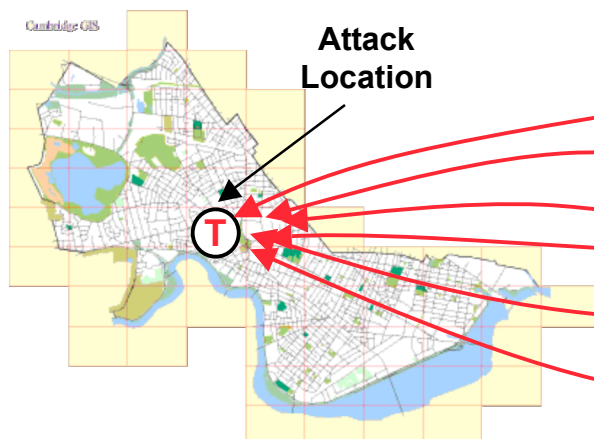
> **Not Localized**
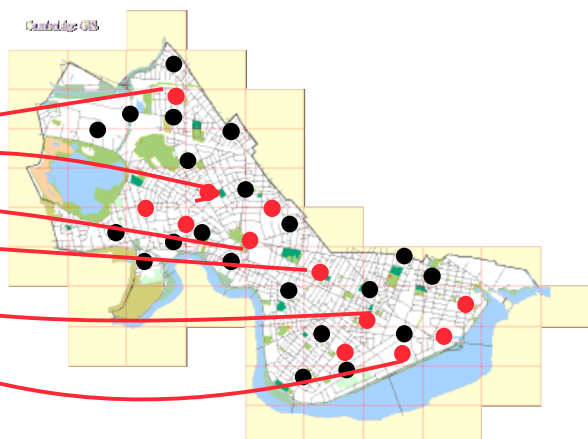> **Not Timely**
> **Detectable**

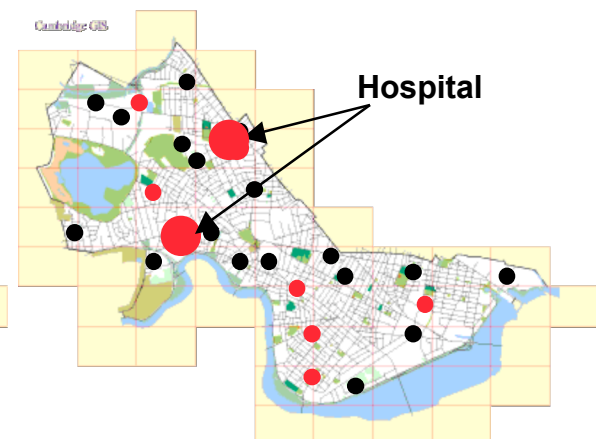# BACTrack
Biological Attack Correlation Tracker

Attack Phase – day 0 **Early Symptom Phase – day 2** **Treatment Phase- day 5**

- **Sampled Population**
  - Participants log a history of location versus time
  - When a participant feels ill, they download their symptoms and track history to a central processing facility

- **BACTrack processing**
  - Tracks of people reporting current symptoms are played back in time
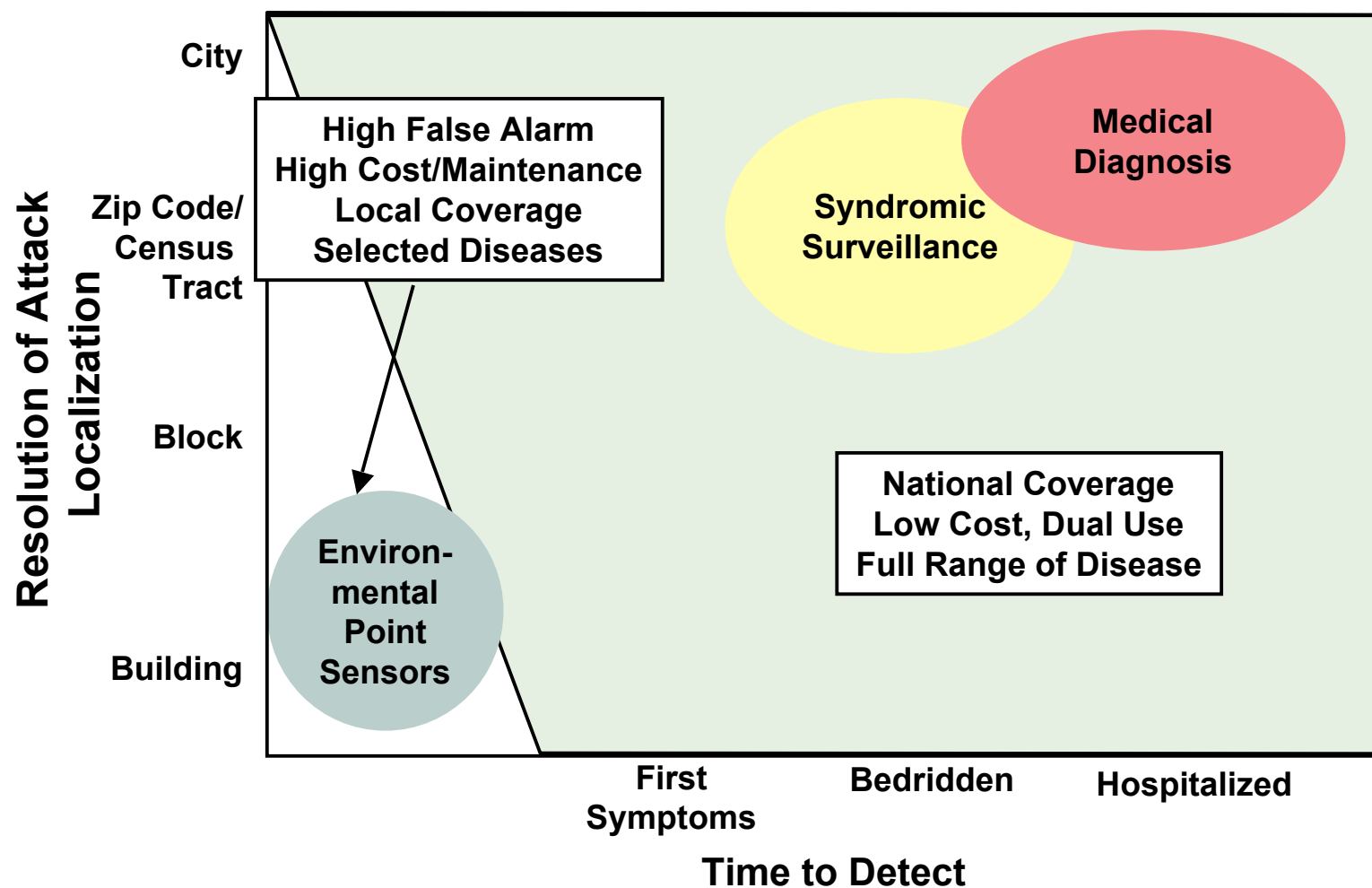 - Attack detection based on finding area with high concentration of symptomatic participants

Unique Aspects of BACTrack

- **BACTrack performs epidemiology in reverse**
  - **First postulate a common point of infection, then follow-up to discover nature of ailment**
  - **Yields simultaneous detection and localization**

- **Utilizes non-specific symptom information**
  - **Filters noisy symptom data through geographical correlation**
  - **Allows automated self-reporting**

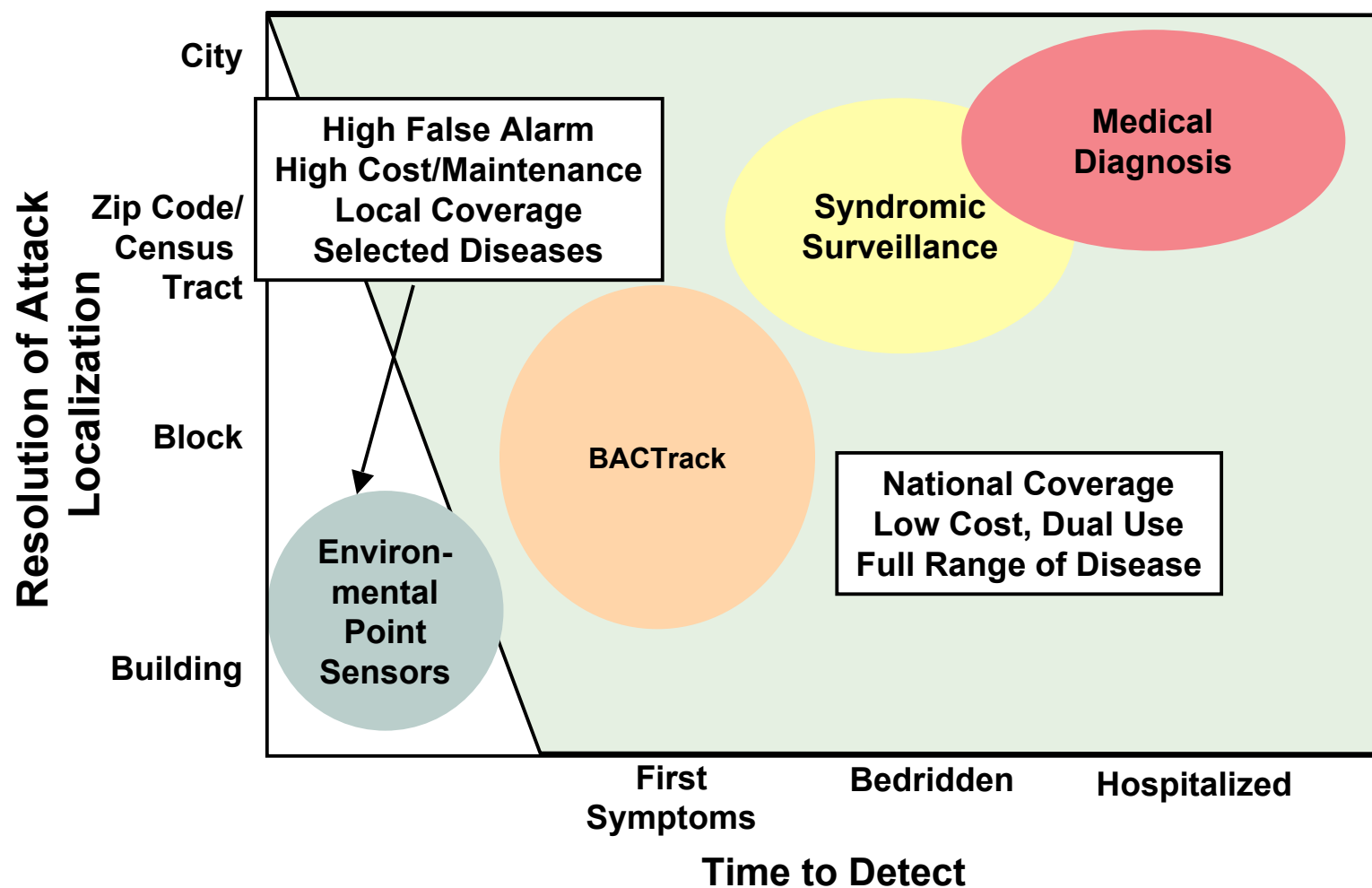- **Location tracking can yield signal-to-noise gain**
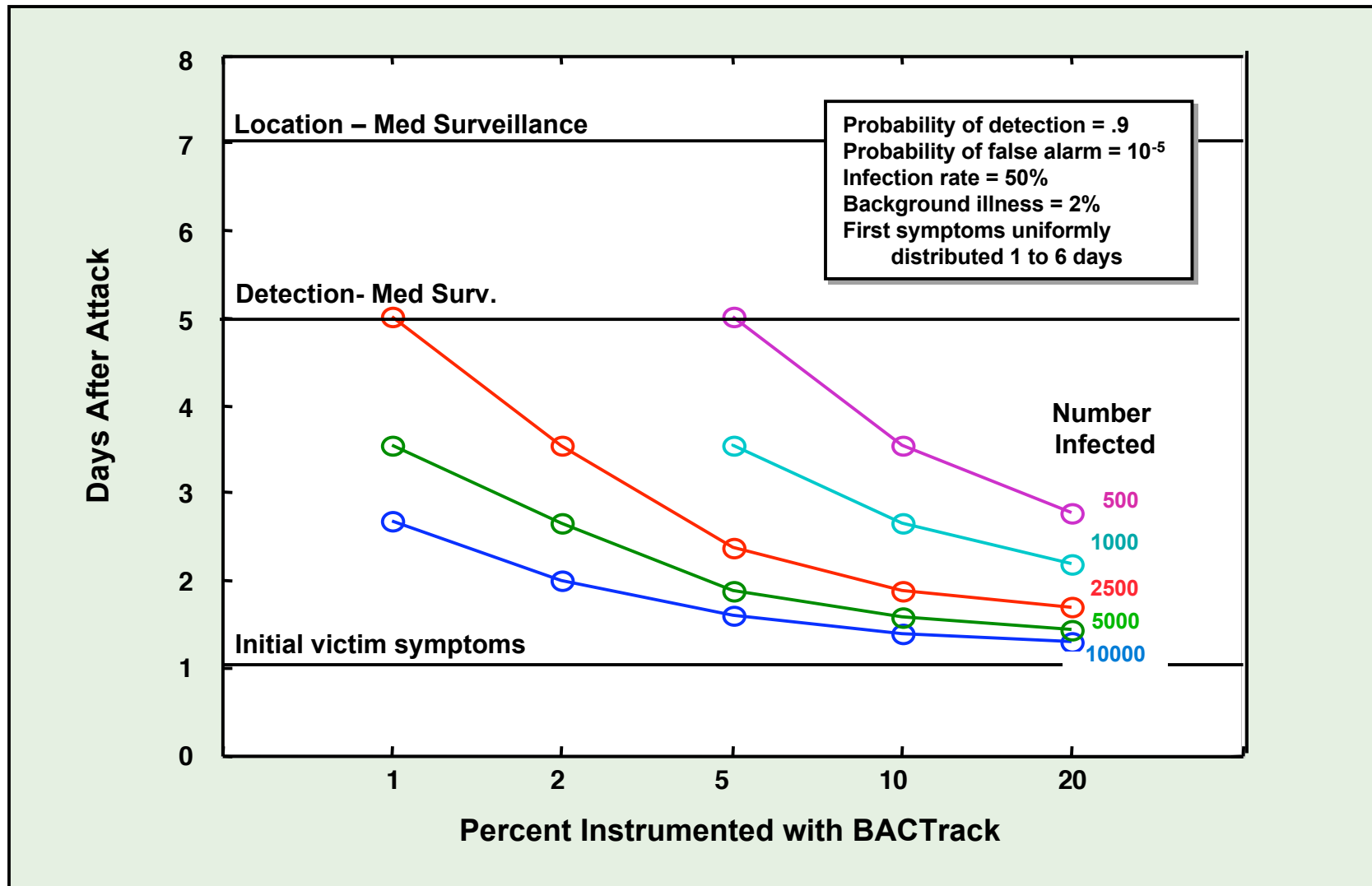
Comparison Of Detection Techniques

Resolution of Attack Localization (y-axis): City, Zip Code/Census Tract, Block, Building

Time to Detect (x-axis): First Symptoms, Bedridden, Hospitalized

Medical Diagnosis

Syndromic Surveillance

**High False Alarm
High Cost/Maintenance
Local Coverage
Selected Diseases**

Environ-mental Point Sensors

**National Coverage
Low Cost, Dual Use
Full Range of Disease**

Comparison Of Detection Techniques

Resolution of Attack Localization (vertical axis)

- City
- Zip Code/Census Tract
- Block
- Building

Time to Detect (horizontal axis)

- First Symptoms
- Bedridden
- Hospitalized

**High False Alarm
High Cost/Maintenance
Local Coverage
Selected Diseases**

**National Coverage
Low Cost, Dual Use
Full Range of Disease**

- Medical Diagnosis
- Syndromic Surveillance
- BACTrack
- Environmental Point Sensors

Key Questions

- **Detection sensitivity and false alarm rate**
  - **Attack size**
  - **Size of instrumented population**
  - **Ambient background illness**
  - **Time to detect**

- **Concept of operations**
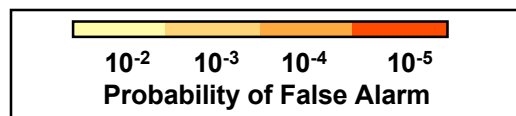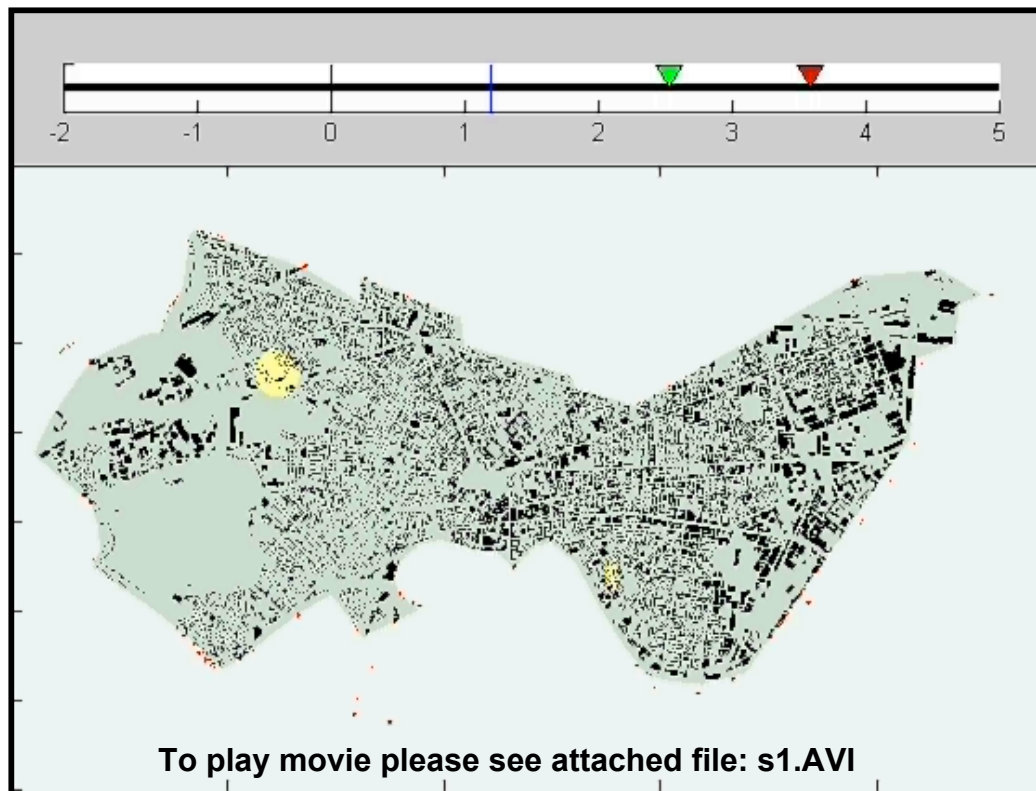 - **Tracking methods**
  - **Surveillance algorithms**
  - **Response**

BACTrack Performance

Building Attack Case

Detection Map

To play movie please see attached file: s1.AVI

10^{-2} 10^{-3} 10^{-4} 10^{-5}
**Probability of False Alarm**

- **Scenario: Anthrax is introduced into HVAC system of supermarket at peak shopping hour**

- **Simulation statistics**
  - **10% of population BACTrack instrumented**
  - **2% background illness**
  - **BACTrack detection based on report from 63 victims**
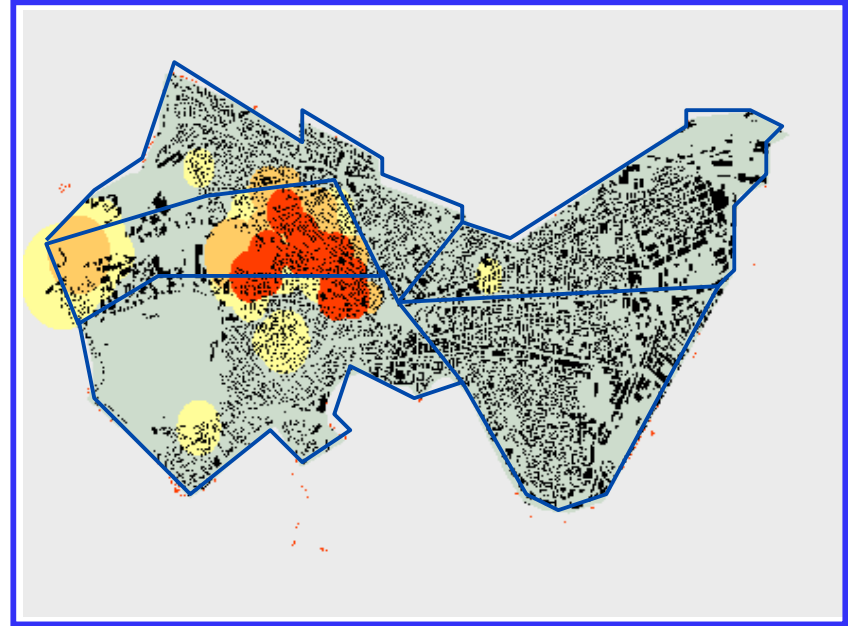
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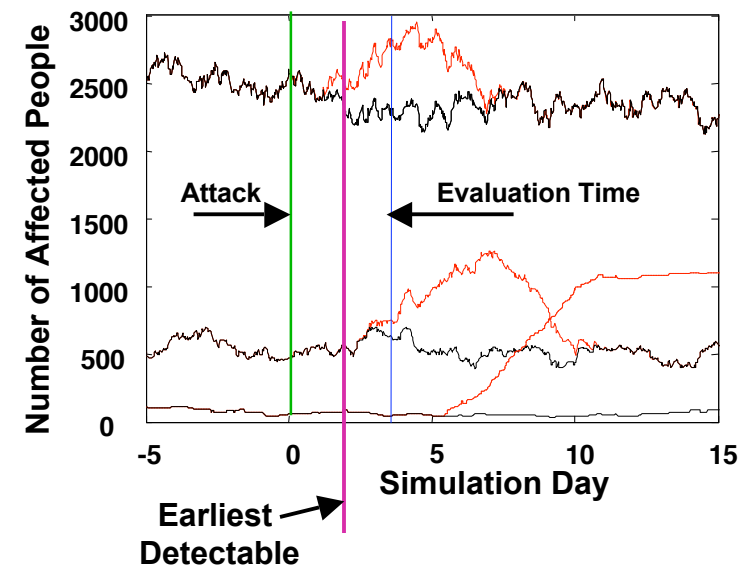
Water-Borne Contamination Case

**Evaluation 5 days after contamination
2.5 days after first symptom**
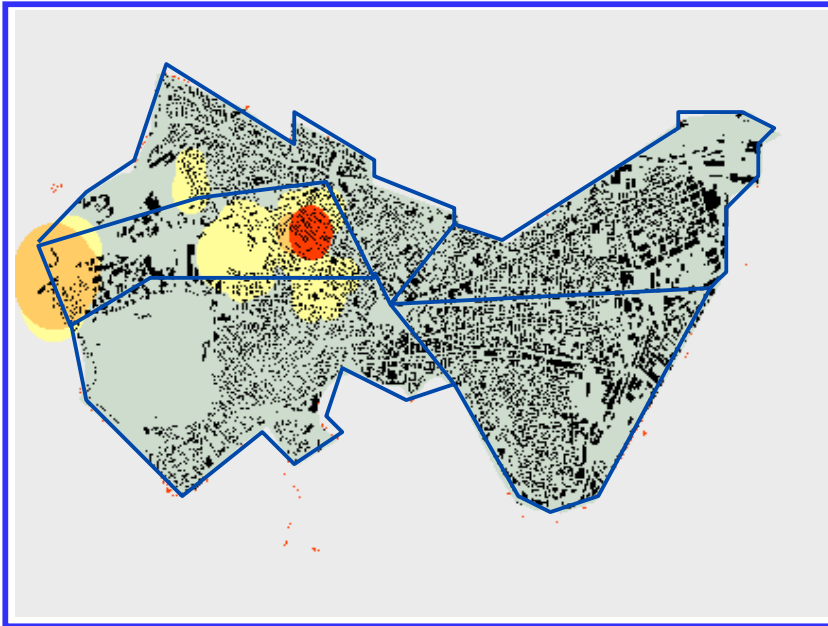
**Evaluation 7 days after contamination
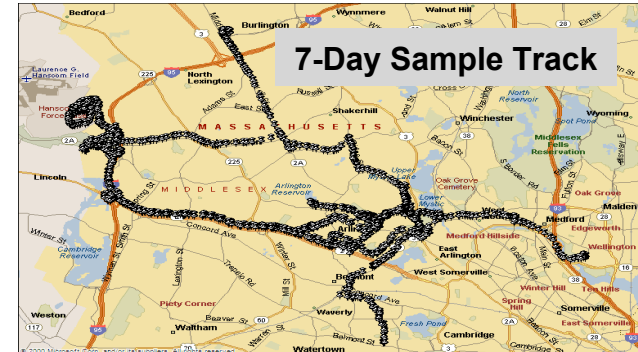4.5 days after first symptom**

- **Waterborne attack detectable < 3 days after first symptom**
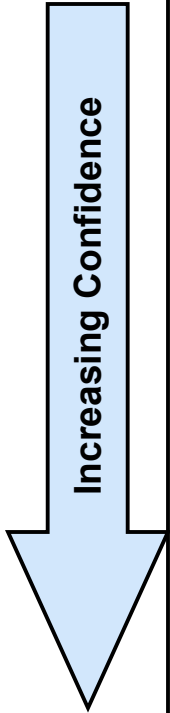- **Simulation demonstrates public health benefit**

BACTrack User Implementation

7-Day Sample Track

- **Location History**
  - Location tracking/storage using cell-phone network
    (geo-location mandated by 2006)

- **Subscription Services**
  - BACTrack location available as a phone provider service
  - Interactive Location Based Service forecast to grow to $4B/year market by 2006

- **User Reporting**
  - User reports symptoms through automated cell-phone interface using password
    - Individual reports only releasable with password
    - Summary information available to health department and all users

- **User Benefits**
  - User receives public health information including attack alerts and natural disease outbreaks

Response Sequence

	First responders Forensics	Docs/Hospitals Public Health

**Obtain additional site
information**
 	
Environmental Testing
 	
Medical Alert
 	
Proxy Testing
 	
General Public Alert
	• Check local events
	• Phone calls
	• Site visit
	• On-site bio-analysis
	• Lab tests
	• Deny site Access
	• Declare as crime scene
	• Search for perpetrators
		• Increase patient
		  testing
		• Look for other medical
		  indicators
		• Order CDC push-
		  pack
		• Prepare treatment
		  centers
		• Treat most likely
		  victims
		
		• Treat public at
		  large

Increasing Confidence

Summary

- **BACTrack offers a new way to detect and locate bioagent attacks**

- **The study has shown the utility of coupling location history with health information**

  – **Earlier detection and location relative to medical surveillance**

- **The cell-phone location based service market can offer a means to implement BACTrack and to distribute its costs**